Space Weather Technical Forecast

Issued on Tuesday, 02 July 2024 at 01:11 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-class flares throughout. Chance of G1/G2 Minor/Moderate storm intervals days 1-2 (02-03 Jul), and again on day 4 (05 Jul) due to CME influences.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has been Moderate, with an impulsive low-level M2.1 flare observed from AR3730 in the southwest at 01/1102UTC. There are currently thirteen regions on the disc. AR3729 in the southeast quadrant is currently the largest and most magnetically complex region, which has developed a tenuous delta spot within the penumbra of one of its leading spots. This region continues to show some gradual development of intermediate spots. AR3734 in the northeast quadrant is also a moderately long spot but smaller in areal extent, showing limited magnetic complexity and minor changes to intermediate spots. AR3730 in the southwest, has now began to decline after the M-class flare, though a north-south aligned magnetic orientation is still observed here. All other spots are small and simple. AR2719 rotated around the southwest limb and AR3720 faded to plage.

A large filament in the southwest was observed lifting off from the Sun's surface around 29/1530UTC, with a subsequent CME observed in coronagraph imagery. Analysis suggests this could give a glancing blow at Earth on days 1 or 2 (02-03 Jul).

A further CME was observed following the aforementioned M2.1 flare from AR3730 in the southwest quadrant, which has been analysed and suggests a possible glancing blow on day 4 (05 Jul).

No other Earth-directed have been observed in imagery during the past 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE and DSCOVR at L1 are indicative of waning CME effects, after the arrival on 28 Jun. Winds speeds have been at elevated to slightly elevated levels, ranging from 430-560km/s. Density was below average. The Interplanetary Magnetic Field, Bt, was weak and on a declining trend, falling from 5nT to around 3nT. The north-south component, Bz, varied weakly between +3/-4nT. Phi angle has been predominantly positive (away from the Sun). Geomagnetic activity was Quiet (Kp1-2).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES18 remained at background levels. High energy electron flux (greater than 2MeV) observed by GOES16 reached Moderate, with a peak of 290 pfu at 01/1930UTC. The 24-hour fluence remained below Active, with 5.44e6 integrated pfu observed at 02/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is likely to continue, with a chance of isolated M-flares.

Solar Wind / Geomagnetic Activity: Effects from the CME that arrived at Earth on 28 Jun

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continue to wane. A CME from a large filament lift-off on 29 Jun may give a glancing blow either on day 1 or day 2 (02-03 Jul). A second CME, which left the Sun on the 01 Jul, following an impulsive M2.1 flare from AR3730 in the southwest, has been analysed, which suggests a possible glancing blow on day 4 (05 Jul). Otherwise, there are no significant coronal holes on the disc to give any fast wind influence.

Geomagnetic activity is expected to be generally Quiet to Unsettled (Kp1-3), with Active (Kp4) intervals and a chance of G1/Minor to G2/Moderate storms (Kp5-6) on either day 1 (02 Jul) or day 2 (03 Jul) under CME influence, however confidence is fairly low. Returning to mostly Quiet to Unsettled conditions on day 3 (04 Jul). A further enhancement is possible on day 4 (05 Jul) due to another potential glancing blow from the CME which left the Sun on 01 Jul, with a slight chance of G1-G2/Minor-Moderate Storm intervals.

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain at background levels. However, there is a very slight chance of exceeding the S1/Minor Storm threshold should any notable flares occur. High energy electron flux might show an increasing trend after the recent CME influence, though further suppressions are possible with further glancing CME arrivals in the forecast. The associated 24-hour fluence is likely to remain below the Active threshold however, with a slight chance of exceeding later in the period.

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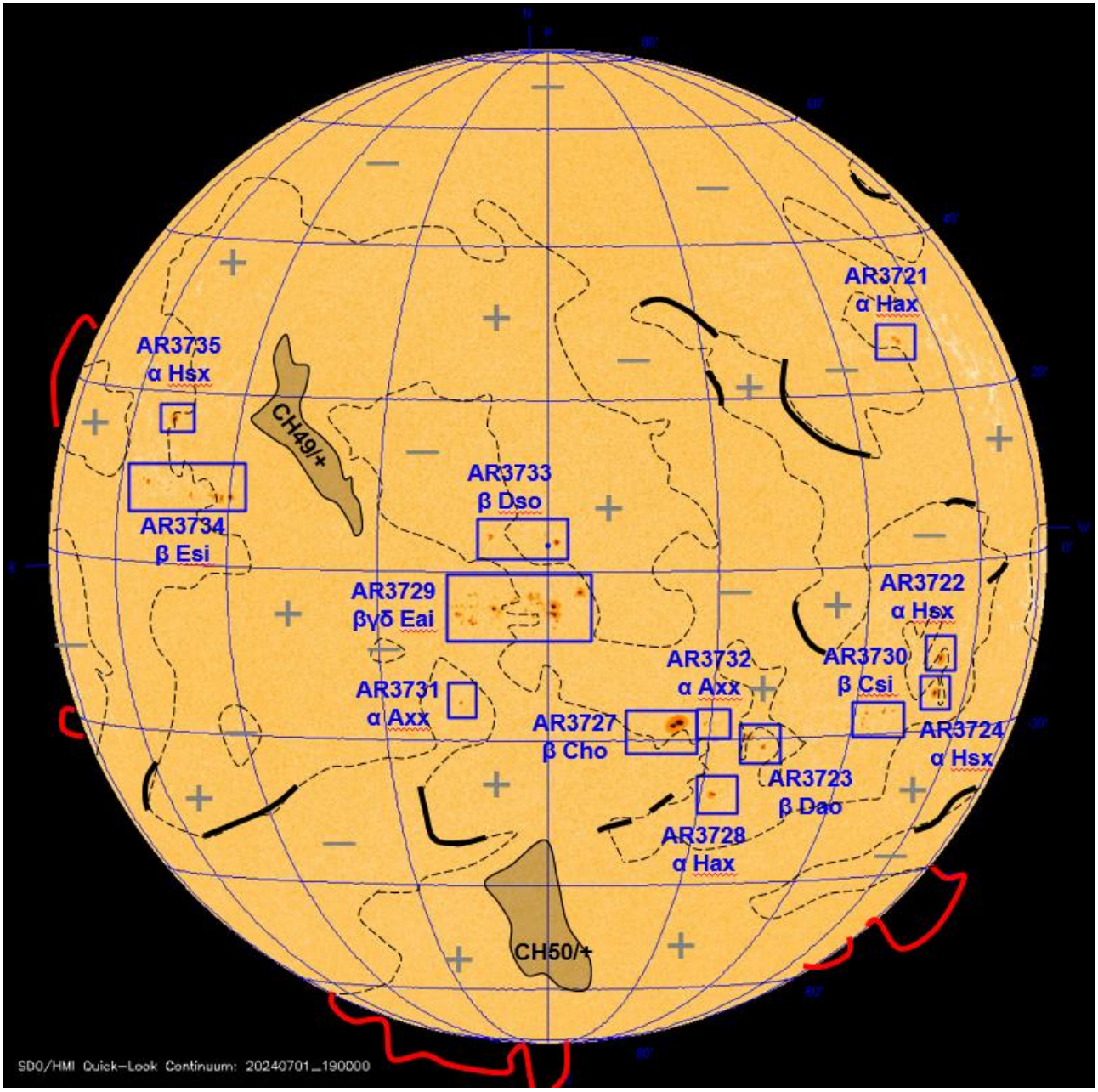
Figure 1. Solar Analysis Valid 01/1900 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Effects from the CME that arrived at Earth on 28/0910 UTC continue to wane. A large filament lift-off was observed around 29/1530 UTC in the southwest, with a resulting large CME observed leaving the Sun in coronagraph imagery. Analysis suggests a glancing blow either on day 1 or day 2 (02-03 Jul) with the bulk of the ejecta passing below Earth's orbit. There is significant uncertainty in the timing of this feature, however.

A second CME features in the forecast, which was associated with a M2.1 impulsive flare, which originated from AR3730 in the southwest at 01/1102UTC. This produced a CME, which has been analysed and results suggest a possible glancing blow on day 4 (05 Jul).

There are no significant coronal holes on the disc to give any fast wind influence.

Geomagnetic activity is expected to be generally Quiet to Unsettled (Kp 1-3), with Active (Kp 4) intervals and a chance of G1/Minor to G2/Moderate storms (Kp 5-6) on days 1-2 (02-03 July) under CME influence, however confidence is fairly low. Returning to mostly Quiet to Unsettled conditions on day 3 (04 Jul). A further enhancement is possible on day 4 (05 Jul) due to another potential glancing blow from the CME which left the Sun on 01 Jul, with a slight chance of G1-G2/Minor-Moderate Storm intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	40	30	5	30
Strong	G3	No	10	5	1	5
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
29/2010	Partial	Filament	SW	780 km/s	03/0000UTC +/- 12 hrs	Glancing blow likely. Timing uncertain.
01/1830	Partial	M2.1 flare	SW	460 km/s	05/2100UTC	Glancing blow likely.

Figure 2: MOSWOC Enlil and Ensemble showing potential glancing CMEs over the coming days.

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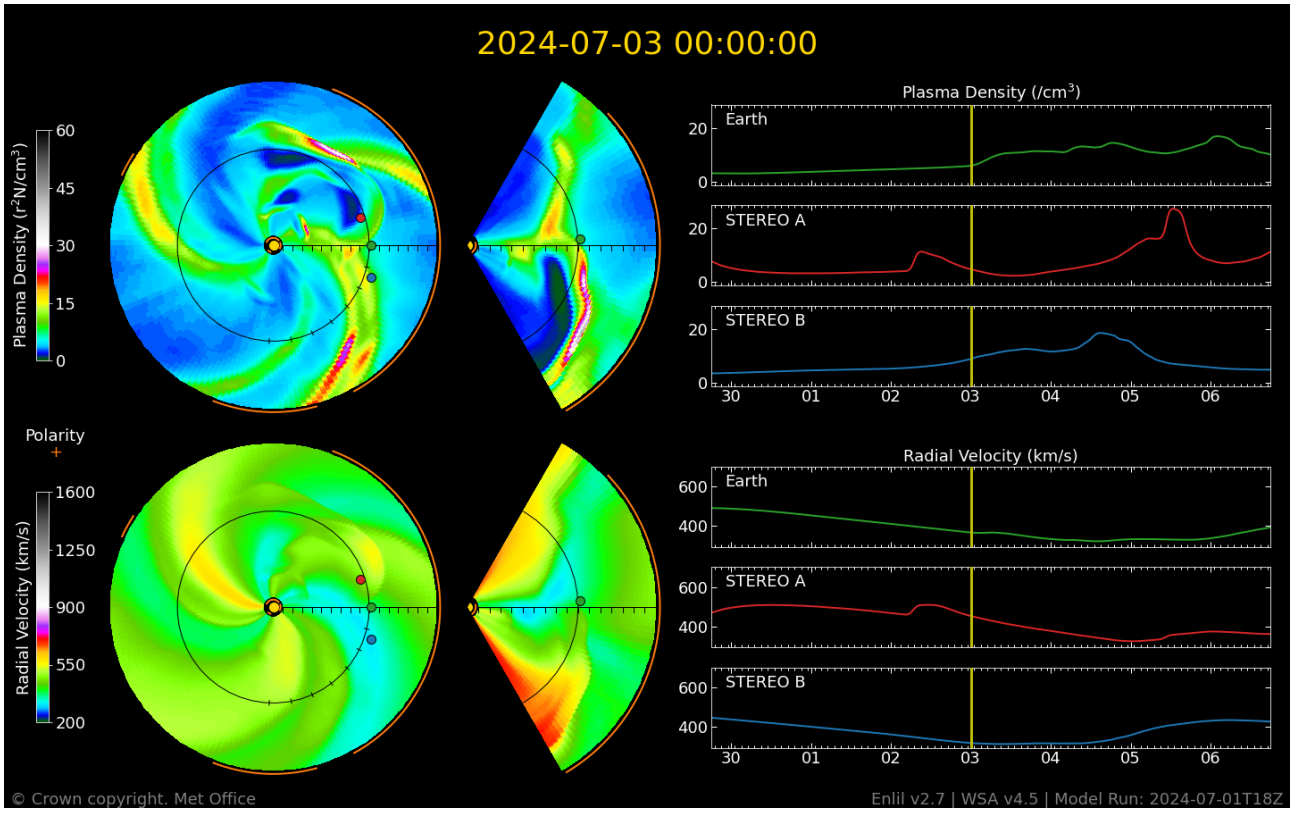
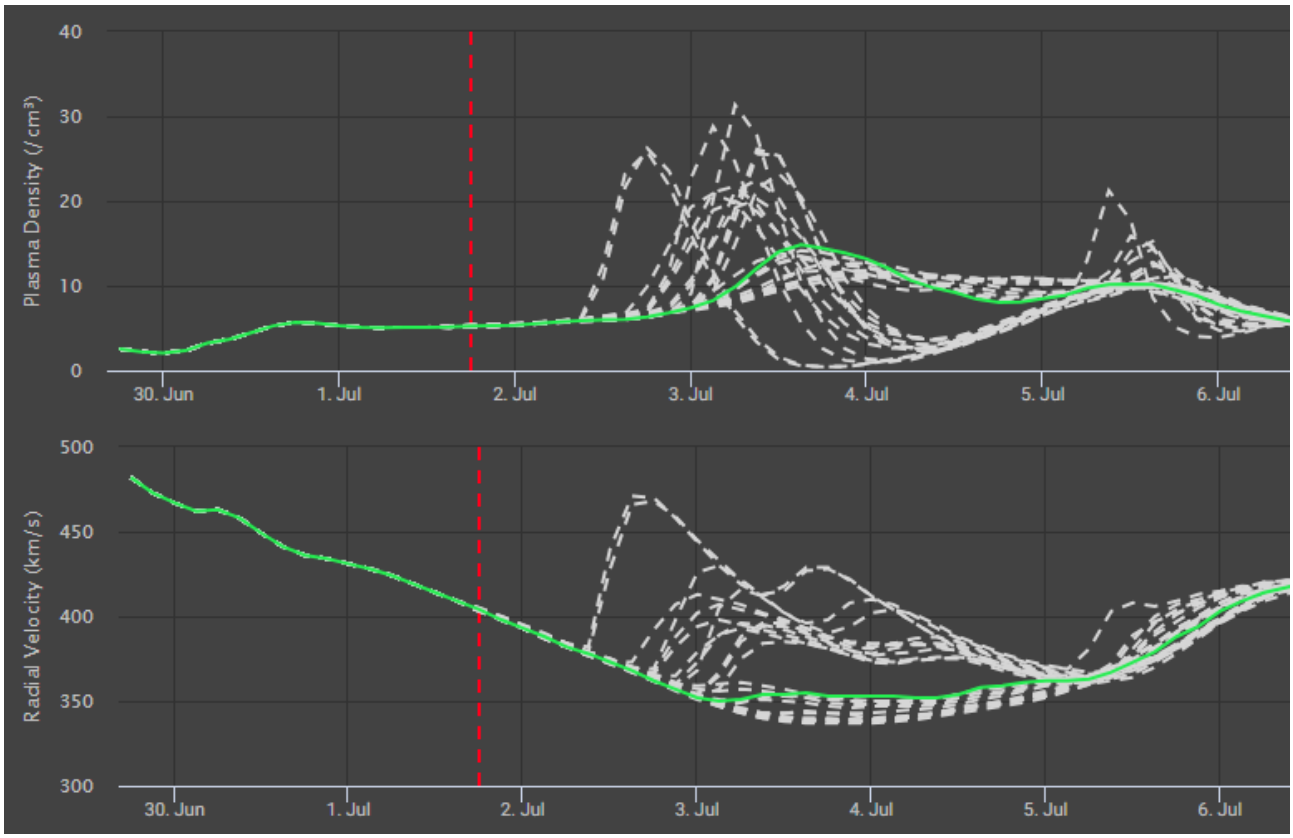
Space Weather Technical Forecast





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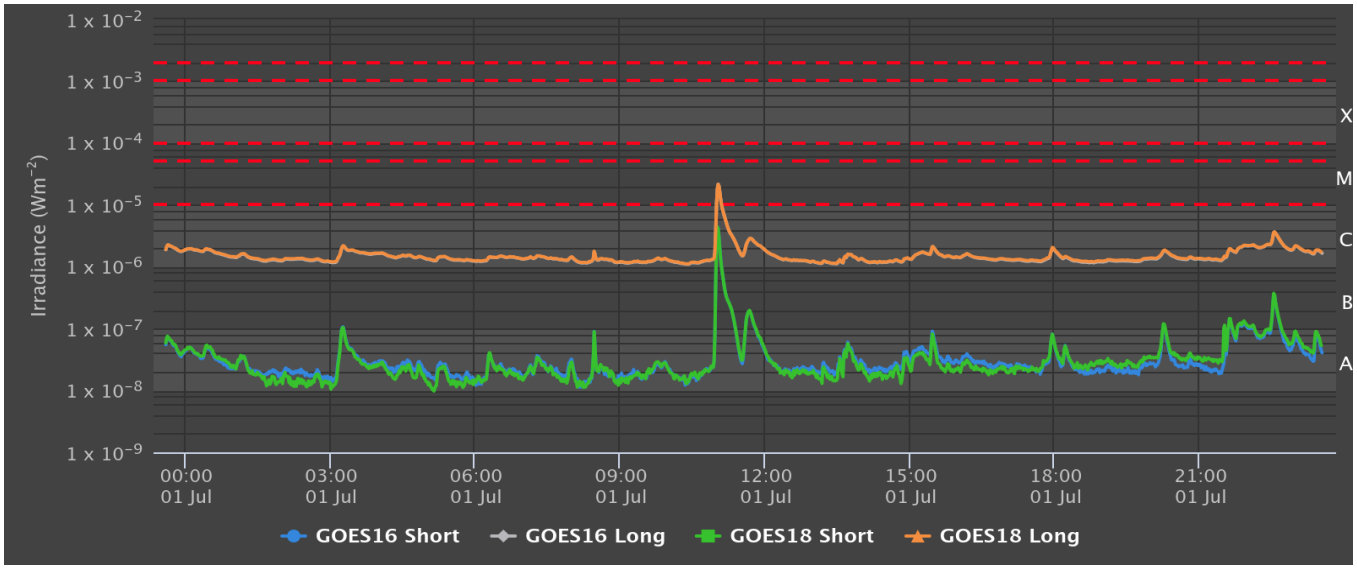
Radio Blackouts - X-Ray Flares:
There are currently thirteen regions on the disc. AR3729 in the southeast quadrant is currently the largest and most magnetically complex region, which has developed a tenuous delta spot within the penumbra of one of its leading spots. This region continues to show some gradual development of intermediate spots. AR3734 in the northeast quadrant is also a moderately long spot but smaller in areal extent, showing limited magnetic complexity and minor changes to intermediate spots. AR3730 in the southwest, has now began to decline after the M-class flare, though a north-south aligned magnetic orientation is still observed here. All other spots are small and simple.

Each individual region only contributes a small amount to the overall flare risk. Overall, the flare risk has been kept flat throughout with a chance of isolated M-class flares, and a very slight chance of X-class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES X-Ray flux trace – shows the M2.1 flare at 01/1102UTC from AR3730 in the southwest.



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Solar Radiation Storms - (High Energy Protons):

High energy proton flux, as measured by GOES-18, is most likely to remain at background levels. Despite a large amount of sunspots on the Earth-facing disc, they are relatively small and magnetically simple, making proton enhancements unlikely.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux, as observed by GOES-16, is expected to continue at background levels for the start of the period. The recent CME enhancement may have caused an increase in electron flux below GEO, but the potential for further CME arrivals could suppress this once again. Overall, electron flux is most likely to stay at background levels, but as the solar wind speeds decline there is the possibility of an increase to peak at moderate levels at times.

Associated electron fluence is most likely to persist below the Active threshold (1e8 integrated pfu), but with a slight chance of an increase above Active later in the period. MOSWOC REFM is forecasting a below Active trend through the next three days, which reflects the most probable outcome, although very dependent on potential CME arrivals, which are currently in the forecast.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	5	10	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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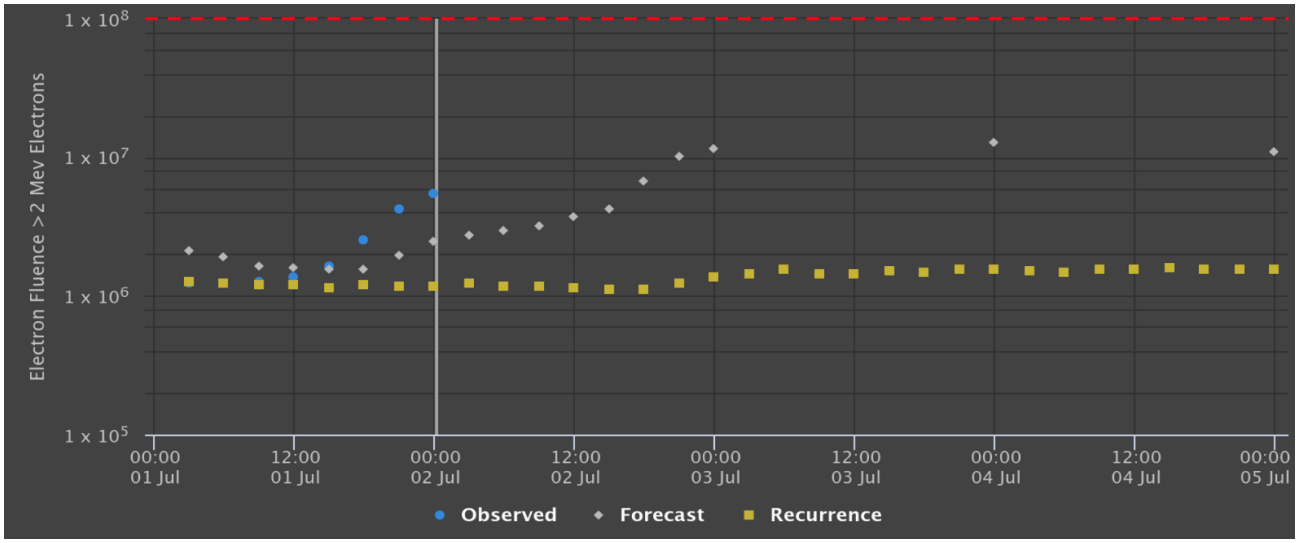
Figure 4: MOSWOC REFM electron fluence – observation, forecast and recurrence.



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